THE ENVIRONMENTAL FUTURE

Emerging Challenges and Opportunities for EPA

A Report from the National Advisory Council for Environmental Policy and Technology (NACEPT)

September 2002

EPA United States Environmental Protection Agency

NOTICE

This report was produced by the National Advisory Council for Environmental Policy and Technology (NACEPT), an independent federal advisory committee providing extramural policy advice to the Administrator of the U.S. Environmental Protection Agency (EPA). NACEPT provides balanced and expert assessments of policy matters related to the environmental programs of the United States. Its operation is supported by the EPA.

The Council consulted with many EPA offices while developing this report. The contents of this report and its recommendations do not necessarily represent the views and policies of EPA, nor of other federal government agencies, nor does the mention of trade names, companies, or commercial products constitute a recommendation or endorsement for use.

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U.S. Environmental Protection Agency
Office of the Administrator
Office of Cooperative Environmental Management
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Letter to the Administrator

September 19, 2002

The Honorable Christine Todd Whitman
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Dear Governor Whitman:

The National Advisory Council for Environmental Policy and Technology (NACEPT) is pleased to present to you our most recent report, *The Environmental Future: Emerging Challenges and Opportunities for EPA*. This report reflects the evolving strategic role that EPA envisioned for the Council in March 2000.

Policymakers too seldom have the opportunity to contemplate long-term or emerging environmental challenges. Futures analysis, the art and science of anticipating nascent environmental issues, can facilitate EPA's proactive planning to prevent potential problems rather than responding after the fact. This report reviews EPA's current futures analysis capability and recommends that more be done to support environmental foresight programs. In addition, the report offers a framework to analyze the environmental implications of trends in world population and demographics, natural resources, science and technology, information management and access, economics and commerce, and politics and social evolution. The report concludes with general and specific recommendations for how EPA can best address these changing conditions.

The unthinkable events of the past year remind us that, along with securing our borders, our nation needs to secure its natural resources and environmental legacy. Concerted efforts to improve environmental foresight will help EPA secure the nation's vital resources and help EPA remain a global leader in applying innovative and effective solutions to complex environmental problems.

NACEPT appreciates this opportunity to advise the EPA and looks forward to a response from you and the program offices affected by these recommendations. The Council also looks forward to an ongoing dialogue with EPA as it continues its role as a strategic and visionary counselor.

Sincerely,

Dorothy Bowers, Chair
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Environmental Policy and Technology

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EXECUTIVE SUMMARY

Our nation's approach to environmental protection has been largely reactive. Environmental laws, institutions and regulations have been created in response to existing environmental and public health threats. Policymakers rarely have the opportunity to contemplate long-term or emerging environmental challenges. Futures analysis, the art and science of anticipating nascent environmental issues, encourages proactive planning to prevent potential problems, rather than responding after the fact.

The National Advisory Council for Environmental Policy and Technology (NACEPT) was asked by the U.S. Environmental Protection Agency (EPA) Administrator to play a more strategic and visionary advisory role in March of 2000. In response, NACEPT agreed to review and recommend environmental foresight methods, and to identify emerging trends and issues relevant to EPA in the next five to ten years.

Understanding the environmental consequences of future social, economic and technological changes can help EPA make better-informed and more strategic decisions. This report recommends a comprehensive, continuous and institutional futures scanning process to identify emerging trends and issues. It also identifies emerging opportunities for EPA and describes the futures analysis framework developed by NACEPT to explore beyond the horizon.

NACEPT recommends that the Administrator of EPA and her senior leadership champion the use of environmental foresight methods. While some EPA offices have made notable progress, more can be done to institutionalize futures analysis into Agency-wide strategic planning processes. This will require the dedication of staff and resources to make environmental foresight an EPA priority. This report identifies several overarching proposals to improve EPA's ability to anticipate and address emerging environmental challenges. These include the following:

- Create an ongoing scanning process that involves all major parts of EPA.

- Support the ongoing work of EPA's Futures Network and provide additional training on environmental scanning, scenario development, and modeling.

- Incorporate futures analysis into EPA's strategic planning. Integrate scanning, scenarios, and other foresight methodologies into the formal planning process.

In identifying the most significant emerging challenges and opportunities for EPA, NACEPT created a foresight framework which divides human activities into six broad themes for analysis. These themes include: World Population and Demographics, Natural Resources, Science and Technology, Information Management and Access, Economics and Commerce, and Politics and Social Evolution. The report analyzes each of these themes and provides an overview of emerging developments entitled Forecast and Context. It also describes the *Desired State* of the future and the *Opportunities for EPA* to move forward. The opportunities are formal recommendations for the EPA Administrator and the Agency's senior leadership.

This report divides *Opportunities for EPA* into immediate, mid-term and long-term categories. A summary of the recommendations can be found on page 59 of this report. The NACEPT Council recognizes that this long list of recommendations represents a snapshot of emerging issues for EPA to proactively and strategically address. NACEPT looks forward to continuing its work with the Administrator and the EPA program offices to respond to these recommendations.

The Environmental Future: Emerging Challenges and Opportunities for EPA

A Report of the National Advisory Council for Environmental Policy and Technology

SECTION I. INTRODUCTION

In March 2000, the Administrator of the U.S. Environmental Protection Agency (EPA) asked the National Advisory Council for Environmental Policy and Technology (NACEPT) to play a more strategic and visionary role in advising EPA. In its efforts to incorporate this new responsibility, NACEPT embarked on a journey that explored strategic planning tools with a focus on environmental foresight. Specifically, NACEPT agreed to recommend a process to identify emerging trends and to prepare its own assessment of these challenges and their implications for EPA.

NACEPT is a federal advisory committee that counsels the EPA Administrator on a broad range of domestic and international environmental policy, technology, and management issues. The Council is a balanced panel of outside experts who represent diverse interests from academia, non-governmental organizations (NGOs), business, industry, state, tribal and local governments. To address the Administrator's charge, a subset of the Council organized as the Emerging Trends and Issues Workgroup. Workgroup members met with leading futurists, consulted with EPA program offices, reviewed futures analysis processes and developed this report through numerous meetings and conference calls. The Workgroup periodically reported its progress to the full Council and submitted draft recommendations for discussion and modification. This final report is the Council's response to the Administrator's request.

Our Environmental Security

No one saw it coming and no one predicted the horror. The events of September 11, 2001 and the subsequent war on terrorism have turned the nation's focus to homeland security and the work of disabling international terrorist organizations. These events have permanently changed the way America does business and should serve as a clarion call for Americans concerned with protecting our natural resources and our environmental legacy. If we learned one thing from those events, it is the value of looking ahead – a concerted effort at improving environmental foresight can help EPA secure the nation's vital resources.

Like many federal agencies, EPA will play a critical role in our nation's war on terrorism. One important role EPA can play involves the increased use of environmental foresight. EPA should continue to assess the state of our nation's environment, to research and identify environmental stressors, and to implement a national strategy to address those stressors. But to effectively carry out this function, EPA will need to look increasingly farther into the future to anticipate challenges and to identify opportunities for environmental improvement and security. This future visioning should be a rational, ongoing "aiming of the radar." The purpose of this report is to share the results and recommendations from NACEPT's own first scan of the radar.

Environmental Surprise and Foresight

Ecologist C.S. Holling coined the term "environmental surprise" to refer to environmental phenomena in which reality departs qualitatively from expectations. Recent history is replete with examples of these unanticipated environmental events: the depletion of the ozone layer by chlorofluorocarbons; the devastating biological effects of DDT, thalidomide, and other chemicals; the nuclear disaster at Chernobyl and the chemical catastrophe at Bhopal; and the emergence of AIDS and other lethal viruses.

In the past, environmental laws, institutions and regulations were created in response to existing environmental and public health threats. Future environmental protection efforts must seek to anticipate emerging threats. Indeed, more environmental surprises lie ahead as human numbers grow, economic output expands, globalization and urbanization continue, and new technologies emerge. Some events will be inherently unpredictable, but there are many others that can be anticipated and assessed, and their negative effects mitigated or forestalled.

In its 1995 report, *Beyond the Horizon*, the EPA Science Advisory Board (SAB) challenged EPA "to begin to anticipate future environmental problems, and then take steps to avoid them, not just respond to them after the fact." While EPA has not fully addressed the SAB's challenge, there has been some notable progress. Innovative environmental foresight efforts are underway in the Office of the Chief Financial Officer (OCFO), the Office of Radiation and Indoor Air (ORIA), the Office of Research and Development (ORD), the Office of International Affairs (OIA), the Office of Prevention, Pesticides, and Toxic Substances (OPPTS), and other units within EPA. Currently, the Managing for Results Steering Group, led by OCFO, is examining ways to integrate futures analysis into strategic planning. Also, OCFO established a *Futures Network*, a group of EPA staff and managers who have strategic planning responsibilities or interest in futures analysis. In 2001, OCFO twice sponsored the *Federal Futures Practitioners Roundtable*, a forum for federal agency foresight and futures professionals. Still, these efforts have yet to result in significant changes to Agency-wide strategic planning and priority setting.

SECTION II.
IMPROVING EPA'S ENVIRONMENTAL FORESIGHT

In its charge, the National Advisory Council for Environmental Policy and Technology (NACEPT) was asked to recommend a process to enhance EPA's ability to identify emerging trends and issues. To be effective, this process must be comprehensive, continuous, and institutional.

Comprehensive means exploring all drivers and trends that can impact EPA's mission, not just selected areas of concern. Like a good radar system, it must continually scan the horizon in all directions. The organization of "themes" detailed below is one framework for a comprehensive radar.

Continuous means a process that is more than a single snapshot; it should be an ongoing, long-term process. The trends and issues identified in this document must be viewed as exemplary, and EPA should understand that these may be constantly changing or shifting.

Finally, by institutional, we mean that the process must be made a long-term activity across EPA. This will require the dedication of staff and resources to monitor future trends and present analyses to senior leadership on a frequent basis. Most importantly, the Administrator and the Agency must prioritize environmental foresight and futures analysis to make it a reality.

Futures analysis anticipates environmental issues and encourages proactive planning to avoid problems, rather than after the fact responses. To implement a futures process, EPA should utilize all the major elements of sound futures analysis. It must include such methodological elements as: literature scanning, Delphi expert panels, frequent extraction and prioritization of issues, and analysis and selection of issues

relevant to EPA's mission. NACEPT can and should serve as a valuable resource for several of the activities in this process. However, EPA needs to dedicate internal resources to make the process fully effective.

In performing the tasks that led to this report, NACEPT followed a regimen that included some of the core methods for sound futurist work. The Emerging Trends and Issues Workgroup assigned individual members with particular expertise the task of identifying major areas that impact EPA's mission. Brainstorming sessions on thematic, organizational, and conceptual structures of issues followed the initial generation of ideas. The Workgroup engaged in a consensus-building exercise with the use of Groupware software – this is akin to Delphi techniques for consensus building – to establish relevance of the issues and trends. In the future, if NACEPT advises an EPA "futurist unit," a more formal process for identifying trends and consequences will need to be adopted. The Workgroup's effort, to date, is a good start.

The Workgroup identified several ways of improving EPA's ability to anticipate and address emerging environmental problems. They include:

- Create and provide resources for an ongoing scanning process that involves all major parts of EPA and make the findings available.

- Support the ongoing work of the EPA *Futures Network*, which includes participants from regional and headquarters offices, who have strategic planning responsibilities or interest in environmental foresight.

- Continue the work done by the *Futures Network* to provide training in methods of environmental scanning, scenario development, modeling, and other methodologies for environmental foresight.

- Encourage environmental foresight efforts in offices and programs throughout EPA, championed by the Administrator and EPA's senior

leadership. Develop standard procedures for sharing and integrating the findings of these efforts, but avoid forcing agreement on any single image of the future.

- Incorporate futures analysis into strategic planning. Scanning, scenarios, and other foresight methodologies need to be integrated into the formal planning process. The EPA strategic plan is a major step forward, but it still lacks a forward-thinking approach. It helps EPA prioritize the problems of today, but gives little or no attention to what tomorrow's problems will be and how they might be prevented or mitigated by the Agency. Environmental foresight tools can help EPA discover new technologies to support a problem-preventing approach.

- Evaluate current programs and environmental protection activities that could provide warning – or be positioned to avoid the occurrence or mitigate the impact – of unlikely but catastrophic events such as: terrorist attacks, disease epidemics, loss of a keystone species, or unexpected consequences of technological advances, etc.

- Develop a workforce better able to assess emerging challenges and equipped with skills and competencies that will be needed in the future. EPA is already moving in the direction of hiring people with multiple points of expertise, rather than specialists in a narrow field. It needs to continue moving in this direction and to give even more attention to hiring and promoting people with a wide breadth of knowledge and cross-discipline experience. Better environmental foresight requires analysts and managers who are able to take a broad cross-media perspective and see connections across problem domains and disciplines.

- Regularly sample the opinions of a broad range of knowledgeable outside experts to enhance cross-fertilization of ideas. Reach out to different sectors not typically involved in regulation activities, such as those involved in research and development on leading-edge technologies and industrial processes.

- Support more work at the edges (and across edges) of conceptual and problem areas. Encourage the airing – and rigorous evaluation – of unconventional and "outlier" views.

- Continuously strive to make management systems more adaptive. Organizational theory suggests that internal openness, active links to a wide range of outside parties and stakeholders, a culture that rewards continuous learning, and structural flexibility, make organizations better able to deal with surprise.

- Improve response capabilities for early warning, leadership alerting, and rapid mobilization to deal with emerging developments that cannot be anticipated.

These recommendations are designed to help EPA develop more comprehensive, continuous and institutional environmental foresight. The next section of this report will detail the recommendations that NACEPT developed after completing its own environmental foresight process.

SECTION III.
EMERGING CHALLENGES AND OPPORTUNITIES

In developing its own views of the most important emerging challenges and opportunities for the U.S. Environmental Protection Agency (EPA), the National Advisory Council for Environmental Policy and Technology (NACEPT) strove to achieve a comprehensive and global perspective. To ensure that its own scanning process was comprehensive, NACEPT divided human activities into six broad themes for analysis:

World Population and Demographics
Natural Resources
Science and Technology
Information Management and Access
Economics and Commerce
Politics and Social Evolution

The bulk of this report deals with an analysis of each of these themes, including: an overview of emerging developments entitled ***Forecast and Context***, a description of the ***Desired State*** that NACEPT believes is facilitative of best environmental management and a sustainable future, and the ***Opportunities*** that exist for EPA to help move toward this desired state. The opportunities are formal recommendations put forward by the NACEPT Council for consideration by the Administrator and EPA's leadership. The ***Summary of Recommendations*** section of the report categorizes these recommendations by EPA's ability to implement them in the short, medium and long term.

WORLD POPULATION AND DEMOGRAPHICS

Forecast and Context

The same underlying driving forces impact all global environmental issues: population, level of consumption, and choice of technologies. While managing population growth is not part of EPA's mandate, its activities, both domestic and international, can have a catalytic impact on population dynamics, economic activity and consumer behavior, and can contribute to significant reductions in both total global and per capita environmental impacts.

The rate of world population growth has declined from a peak of 2.1 percent per year in the early 1960's to 1.3 percent today.[1] Even at this reduced rate, total global population size will continue to increase substantially for several decades because the growth is occurring from such a large base. Between now and the year 2025, population is likely to increase as much as it did from the beginning of human history to World War II.[2] By then, the world is expected to have nearly 8 billion people. Almost all of this growth will occur in developing nations in Asia, Africa and Latin America, with most of the new population living in urban areas. The global urban population is projected to increase from 2.6 billion in 1995 to over 4.5 billion in 2025.[3]

Rapid population growth, unprecedented rates of urbanization, and the proliferation of megacities with populations exceeding 10 million will challenge the management capabilities of many developing nations. Growth will put enormous pressures on water supplies, agricultural soils, forests, and other renewable resources. While the average age of populations in the Third World is falling, longer life spans in much of the Western industrialized world are leading to an aging population and increased demands on natural resources.

Problems of water and air pollution, and disposal of sewage and solid wastes, will inevitably be severe in rapidly expanding urban agglomerations. Environmental

conditions, in turn, influence health. Poor environmental quality is already estimated to be directly responsible for about 25 percent of all preventable ill health in the world today, with diarrhea and acute respiratory infections heading the list.[4]

The problems are not restricted to areas beyond our borders. For example, Southeast Florida, near the sensitive Everglades ecosystem, is already showing environmental stress associated with rapidly expanding urban areas. The University of Florida estimates that the populations of Miami-Dade, Broward and Palm Beach Counties will increase by more than 2 million from the current levels of approximately 5 million.

One challenge related to population growth stands out from all others: *fostering sustainable development at the global level, while fostering needed economic expansion in the world's poorer nations.* There is now widespread agreement that sustainable development is the key to stabilizing population growth. Since the 1994 International Conference on Population and Development in Cairo, a global consensus has emerged that the best strategy for reducing fertility rates is to empower women, expand economic opportunity, reduce poverty, and increase the availability of education and health care.

Sustainable development is also essential for reducing social unrest and the danger of international terrorism. No mixture of conditions could be more combustible than rapidly expanding numbers of restless young people living in poverty without opportunities for improvement. Constant exposure to global media images of affluent lifestyles and ideologies that preach hatred against America increase their hopelessness and anger.

Development is essential, but development along the pattern of the past is impossible. If billions more people try to move toward U.S. per capita rates of fossil fuel consumption, resource use, and waste generation, it would be environmentally disastrous and fundamentally unsustainable. As a result, the United States has a special responsibility to help create a new model for development – one with minimal environmental impacts. As a world leader and the largest consumer of the world's resources, the United States has the capacity and responsibility to help other nations protect the environment. Pioneering new approaches to sustainable development and sharing new environmental technology may well be our greatest contributions toward the future.

Desired State

- Global and regional populations are stabilized at levels that allow us to live within our global means without undermining the ecological foundations on which our economies are built.

- Poor nations and disenfranchised populations within nations have equitable access to resources needed for rapid development, job creation, and investment in education and health care.

- Environmental impacts per unit of Gross National Product (GNP) are reduced sharply by environmentally superior technologies and development strategies that simultaneously meet basic human needs and protect the environment.

Opportunities for EPA

Elevate EPA's International Role. To do so effectively, EPA needs to have the ability to provide credible information on the long-term implications of population growth, nationally, as well as internationally. EPA should select and analyze population data to help decision-makers understand the impacts.

Raise Awareness of the Importance of Sustainable Development. When interacting with other parts of the federal government, raise awareness of the importance of achieving rapid, sustainable development in poor nations with high population growth rates. To the greatest extent possible, the United States must lead by example, encouraging sustainable development at home.

Support Global Sustainable Development Networks. In cooperation with the United Nations Environment Programme (UNEP) and other international organizations, provide support for global networks of Third World development experts, environmental protection officials, urban planners, and environmentalists.

Facilitate Export of Environmentally Superior Technologies. Help stimulate and organize inter-governmental efforts to export environmentally superior technologies and environmental management methods that reduce impacts of population growth. Revitalize the Environmental Trade Work Group (ETWG), composed of 19 agency heads, which was established to organize more effective trade promotion in exporting environmental technologies. The ETWG is co-chaired by EPA and the Department of Commerce and is a subgroup of the Trade Promotion Coordination Committee (TPCC).

Build Relationships with Developing Countries. EPA offices currently work with sister areas in different parts of the world. Explore what would be needed to target this coverage more effectively. Establish an "Envirocorps" – an environmental Peace Corps – where citizens with professional experience in environmental protection and different areas of environmental technology are trained and paid to work in developing nations. EPA and the Peace Corps can collaborate more closely on international environmental projects.

NATURAL RESOURCES

Environmental issues arise primarily around the use of natural resources, including energy, water, land, food, and wildlife. The principles for managing natural resources in a sustainable way are similar across all these areas. Key principles include:

Efficiency. Decrease environmental impacts per unit of gross national product (GNP) by using natural resources more efficiently. Increasing resource efficiency is virtually synonymous with cutting waste because pollution represents wasted materials being released into the environment.

Industrial Ecology. Using nature to model our technical systems, close the loops of material flows by reusing or reconfiguring the material outputs of each process into inputs for other purposes.

Appropriate Use of Renewable Resources. With the exception of energy, which is constantly supplanted by solar radiation, all terrestrial natural resource systems are closed. These systems have no external sources to replenish raw material supplies. Emphasize the use of renewable resources that nature will continue to provide and replenish indefinitely. Keep renewable resource use at, or below, the maximum sustainable yield to maintain the stock from which the flow of resources derives.

Social Well-Being. In making decisions about sources of energy, water supplies, food, and other important issues, strive to understand what approach will most likely improve the social well-being of everyone, especially those who have suffered injustices, poverty, and other barriers to achieving their potential.

Sustainable Development. Use natural resources in a way that meets today's needs without degrading those resources and making it difficult for future generations to meet their needs. Find solutions to natural resource issues that are simultaneously beneficial for economic development, the environment, and social well-being. Only solutions that work on all three levels will lead to the kind of future we want to create.

NATURAL RESOURCES – ENERGY

Forecast and Context

The world is not facing an energy supply crisis, but rather an energy management problem. The United States alone has coal reserves that could last for centuries and, more importantly, abundant solar radiation will be available for billions of years. The primary challenge today is energy management: to reduce the carbon intensity of the energy economy and to facilitate the conversion to renewable sources and hydrogen storage. Decarbonization is necessary to limit environmental impacts, from multi-pollutant air emissions to global climate change.[5] The key barrier to decarbonization is not economic or technological – it is the lingering misconception that carbon emission limits lead to a reduction in economic growth. The evidence is conclusive that carbon and economic output can be decoupled.[6]

Increasing energy efficiency is the fastest and cheapest decarbonization strategy. In the United States, producing one unit of gross domestic product (GDP) requires less than one-fifth as much energy as it did two centuries ago.[7] Just between 1973 and 1986, increasing energy efficiency made it possible for the GDP to grow by 35 percent with zero growth in energy consumption.[8] Thanks to advancing technology, much larger – and highly profitable – opportunities are available for increasing efficiency further.

Changing energy sources constitutes the other principal decarbonization strategy. Industrial nations have already gone through three historic waves of decarbonization.

Coal released one-fifth to one-tenth of the carbon per unit of energy of the wood it displaced as the dominant fossil fuel.[9] By the 1960's, a lower carbon and more portable fossil fuel, oil, displaced coal as the dominant energy source, marking the second wave of decarbonization.[10] Now, natural gas, the cleanest fossil fuel, whose combustion releases the least carbon dioxide, is ascending toward a dominant role. Decarbonization is arguably the most fundamental trend in the evolution of the energy system.[11]

Now a fourth wave of decarbonization may be appearing on the horizon with the emergence of hydrogen-based energy technologies, such as fuel cells. Initially derived from natural gas, and possibly from ultra-clean coal technology, hydrogen will eventually be produced by splitting water into hydrogen and oxygen using renewable energy. Moving toward a hydrogen economy would tend to take the energy system away from large scale generating technologies toward *virtual utilities* composed of networks of microturbines, solar cells, fuel cells, and other *micropower* technologies. This environmentally benign image of the energy future is being advocated by leaders of some of the world's largest energy companies, such as Royal Dutch Shell, which has created Shell Hydrogen, and BP, which now stands for "Beyond Petroleum."

Desired State

- Energy is used with high efficiency in buildings, transportation, industry and consumer products.
- Major reductions are achieved in the amount of waste (pollution) going into the environment from the production and consumption of energy.
- Decarbonization continues through increasing energy efficiency and changing energy sources.
- Renewable energy is ultimately the primary energy source, forming the basis for a completely carbon-free, renewable hydrogen economy.

- Energy choices are approached as choices about how to make the world work for everyone over the long term – economically, environmentally, and socially.

Opportunities for EPA

Encourage Total Accounting of Energy Technologies. Foster objective, rigorous comparative analyses of the full range of costs and benefits associated with expanding the use of different energy technologies. Bring energy efficiency improvements into the comparative analyses, along with the full range of energy supply options. The analyses should look at cradle-to-grave and intergenerational costs and benefits, including impacts on natural systems, human health, and social well-being. The assessments should consider the implications different options would have if they were adopted, not only in the United States, but also by developing nations. Some aspects of this activity can appropriately be done within EPA. Much of it would be best done in cooperative relationships with other agencies and leading research institutions.

Utilize the Clean Air Act State Implementation Plans (SIPs) Process to Spur Investment in Renewables and Energy Efficiency. Work in partnership with the Department of Energy (DOE) to aggressively break through the barriers that inhibit full crediting of energy efficiency and renewable energy technologies in SIPs. If EPA fully credits energy efficiency and renewable energy programs in SIPs, more capital would be channeled into technologies that can decarbonize the energy system over the long run, as well as produce immediate reductions in a wide variety of air emissions.

Partner with the DOE on the New Freedom Car Project. The administration recently announced a new program to develop and promote hydrogen fuel cell development. The Freedom Car program hopes to have hydrogen fuel cell vehicles on the road within the next ten years.

Support Innovative Research on Sequestering Carbon Dioxide. A number of innovative concepts for using fossil fuels with minimum climatic harm have yet to receive serious attention. For example, academic researchers have suggested the possibility of reforming natural gas into hydrogen at the wellhead and re-injecting the carbon dioxide produced in this process into the geological formation from which the gas was taken. EPA should scan for other innovative sequestration concepts and ensure that they receive attention in other agencies and the private sector.

Expand the Energy Star Program. Expand the highly successful and cost-effective Energy Star program to other sectors, such as grocery stores and the health care industry. Partner with DOE to develop energy efficiency programs relevant to these new sectors.

Establish a Green Vehicle Labeling Program. The concept of green labeling for vehicles has been developed and discussed in the Green Vehicle Guide (EPA, Mobile Sources). Putting this concept into practice would give consumers better information on vehicle fuel efficiency, as well as new information on emissions, manufacturing toxins, etc.

Promote Market-Oriented Measures for Reducing Global Warming. Within the executive branch and in interactions with Congress, promote the adoption of market-oriented policy measures that reduce global warming by increasing energy efficiency.

Encourage Research on Hydrogen as an Energy Carrier. Encourage research and development on hydrogen as an energy carrier and energy storage medium. Ensure that environmental issues related to hydrogen are identified at the front end, so that potential problems are avoided and an appropriate federal regulatory role is developed (e.g., *Design for Environment* in fuel cell production, fuel cell recycling and disposal, and pipeline issues).

Use Publicly Owned Sewage Plants to Demonstrate Hydrogen Technologies. Create demonstration projects with major methane sources, such as publicly owned wastewater treatment plants (sewage plants), to demonstrate methane-to-hydrogen conversion and the use of hydrogen technologies. Assess regulatory and economic constraints that need to be overcome. Currently, every wastewater treatment plant generates considerable quantities of methane, a major greenhouse gas. Many use this methane for heating digestion process units during winter months, but 80 percent or more may be flared off in summer. Converting methane to hydrogen would allow these plants to generate a substantial amount of their own electricity on-site year-round.

NATURAL RESOURCES – WATER

Forecast and Context

Water is the world's most important natural resource. It is essential for human and ecosystem health and for the production of all ecosystem goods and services. It is the primary input to agriculture and the most widely used resource in industrial processes. It has aesthetic, cultural and recreational value. It is also the natural resource where the most severe environmental problems occur the soonest.

Today, 2.3 billion people live in water-stressed countries where there are growing conflicts between different users of water.[12] Of this group, 1.7 billion live in areas of real water scarcity, where drought and water diversions for agriculture and industry limit the amount of water available to meet people's basic needs.[13] In the quest for more water, many of the major aquifers around the world are being drained at rates that exceed their natural recharge rates. By 2025, an estimated 2.7 billion people will live in areas experiencing severe water scarcity, creating a potential for regional conflicts over water rights in the Middle East, sub-Saharan Africa, and large parts of Asia.[14] Even where water

is not scarce, it is often contaminated. Globally, only about 10 percent of all wastewater is treated before it enters rivers and other bodies of water.[15] On every continent, groundwater, as well as surface water, is being contaminated and rising sea levels from global warming threaten further contamination. As populations and economies grow, water use on the pattern of the past will prove unsustainable and "water efficiency" will become as important a concept as energy efficiency.

The United States, as a whole, does not yet face widespread, serious water shortage problems. However, the warning signs are clear: the massive Ogallala aquifer has been severely depleted, Great Lakes water elevations are at their lowest levels in decades, the California agricultural economy consumes far more water for irrigation purposes than can be sustained over the long term, and rapid urbanization of rural and previously undeveloped regions (e.g., Las Vegas) is proceeding without consideration of water supply concerns. Disruptions in the hydrological cycle due to global warming or other meteorological factors may make drought conditions more common over the decades ahead, and the increased draw down of aquifers may limit development in some areas, and force major agricultural management changes in others. Moreover, the draw down of deep aquifers brings water with higher salt concentrations to the surface, potentially exposing croplands to dust-bowl vulnerabilities. Major water management issues already impacting the United States include maintaining and improving the wastewater infrastructure to avoid further water contamination.

Disputes over water management are taking place in the arid Southwest and elsewhere in the United States. Georgia, Alabama and Florida have been fighting for years over two river systems that give life to the Southeast. In 1997, they decided to form an interstate compact to develop an agreement on how the rivers should be used. But after three years, five extensions and at least $20 million, there's no agreement in sight.

Much of the nation's infrastructure for drinking water, wastewater, and stormwater is aging. Increased demand on public water systems, caused by a growing population, will make it difficult to maintain potable water quality standards. Many system managers are not budgeting for, nor do they have sufficient access to funds, to

make the investments in infrastructure maintenance that are likely to be necessary. In agriculture, lack of investment in irrigation infrastructure is causing growing problems of unnecessary water loss from canal leakage, infiltration, and salinization. New investments are required in "precision agriculture" systems that apply only as much water (and other inputs) as needed, when needed. Water subsidies that contribute to excessive and wasteful use magnify expenditures needed for infrastructure.

Despite significant improvements in water quality, one-fifth of freshwater fish stocks are still considered vulnerable or endangered because of pollution or habitat disruption.[16] Perhaps the most serious problem is groundwater contamination by nitrates, pesticides, petrochemicals, chlorinated solvents, radioactive wastes, saltwater, and heavy metals. Groundwater that becomes polluted tends to stay polluted for a very long time; the average residence time for groundwater is 1,400 years, as opposed to 16 days for river water.[17]

In the United States, water contamination from point sources has decreased dramatically over the 30-year life of the Federal Water Pollution Control Act. Addressing remaining water quality issues, such as contamination from pharmaceuticals, antibiotics, food additives and pesticides, will require watershed-based approaches that include all contributors: traditional point sources, as well as non-point sources, including agriculture, silviculture, airborne deposition, and stormwater runoff. Innovations will be needed in environmentally advanced agriculture, closed-loop production and consumption systems, and green chemistry to eliminate the use of persistent toxic chemicals.

Desired State

- There is sufficient usable water to meet population needs in the United States and around the world.

- Technologies for achieving higher water efficiency are universally adopted in agriculture, industry and residential use.

- Water rights issues are fairly mediated, avoiding conflicts over access to water.

- Surface water and groundwater are protected from contamination.

- Water is priced at its true cost to reduce wasteful use.

Opportunities for EPA

Develop a Holistic Approach to Water and the Environment. Create a water task force with representatives from several offices in EPA, other federal agencies, and external stakeholders to take a more holistic look at water policy and the environment. Identify major watersheds across the country for specific improvement. Examine a broad range of issues, from aquifer depletion and contamination to water efficiency and the level of investment needed to maintain aging water infrastructure. Examine potential environmental implications of major water policy options. Make recommendations for the integration of water quality objectives at different levels into a single coherent package.

While there has been significant progress in adopting a more holistic approach to managing water resources over the last decade, existing statutory authorities make it difficult to run programs on a watershed basis. EPA's Office of Water is working to better integrate its authorities under the Clean Water Act and the Safe Drinking Water Act.

Integrate Water Efficiency with Water Quality Standards. Integrate water use efficiency and appropriate reuse into water quality standards and other environmental regulations. A number of current regulatory programs are based on achieving technical standards measured by concentration of pollutants per unit of water. Increased water efficiency goals conflict with these concentration-based regulatory standards.

Support an Effective Market Environment to Minimize Generating Hazardous Wastes. Sixty percent of U.S. hazardous liquid waste – 34 billion liters of solvents, heavy metals and radioactive materials – is injected into deep groundwater around the country by means of injection wells. EPA should assess opportunities to eliminate generating all hazardous waste through pollution prevention/source reduction (P2) and through reprocessing/reuse; identify the technical, regulatory and economic barriers to P2 and reuse; and encourage a market environment in which these beneficial practices become the preferred business option.

Redouble Efforts to Effectively Include Non-Point Sources in Water Management Programs. Enhance EPA's capacity to monitor, model and mitigate non-point source contributions to water contamination and overall environmental degradation. Develop better models for estimating adverse health and economic impacts of non-point pollution. Increase efforts to educate citizens and policymakers about the value of non-point source mitigation and to mobilize political and technical support for federal, state, and local efforts to address the problem.

NATURAL RESOURCES – BIODIVERSITY, LAND AND FOOD

Forecast and Context

Biodiversity, land and food are deeply intertwined resource issues. Habitat loss and degradation are the leading causes of declining biodiversity, affecting 85 percent of all threatened species.[18] The leading cause of habitat loss is conversion of land for low-density urban development, agriculture, and forest plantations. The other leading causes of declining biodiversity are invasive species and pollution, primarily from agricultural runoff.

A generation ago, some scientists looking at the loss of wetlands, rainforests, and other biologically rich areas feared that the total number of species could be cut by 25 to 50 percent within a generation or two – the greatest decline in biodiversity since the cataclysmic end of the age of the dinosaurs. While some field studies suggest that species are more resilient than originally thought,[19] other recent studies suggest that climate change may pose major new threats to biodiversity. Rates of global warming may exceed the migration capabilities of many species, and progressive shifts in climatic conditions will cause losses of existing habitat and reductions in habitat patch size.[20]

Land conservation which encourages greater density in urban and suburban development is one of the most important requirements for preserving biodiversity. More clustered development reduces the entire *footprint* of an urban population. This is important everywhere, but especially crucial in areas like Southeastern Florida around the sensitive Everglades ecosystem where the population is projected to increase by 1.8 million between 2000 and 2020.[21] Clustered development also maintains the recharge rate of groundwater aquifers, which is reduced by impervious urban surfaces. Urban infill and high density development patterns go hand-in-hand with establishing green spaces that are off limits to development, and buying land for parks and open space to protect wildlife.

Limiting urban sprawl can also protect prime agricultural land. For example, in California's Central Valley, where the population is expected to triple by 2040, cropland losses could be cut by 55 percent simply by building 15 residential units per hectare, instead of the more typical 7 units.[22] A denser urban environment also facilitates the use of mass transit, saves money on construction and upkeep of infrastructure of many kinds, provides lower income people easier access to jobs, and tends to promote a greater sense of community.

The spread of exotic species of plants, animals and diseases is now second only to habitat loss as a cause of declining biodiversity and ecological destruction. The slow migration of species into new habitats has always been a part of nature, but the globalization of commerce and travel has accelerated this process so drastically that it deserves to be considered a new phenomenon in the history of life. *Bioinvasion* by invasive species needs to be treated as a major new challenge, as important as regulating the pollution of land, water and air.

Reducing pollution, especially the agricultural runoff from erosion, over fertilization, and heavy use of pesticides, is the other major requirement for preserving biodiversity. One of the greatest challenges ahead is developing an environmentally advanced agriculture that puts together the most environmentally sound and productive methods from many different areas including: conventional industrial agriculture, agricultural biotechnology, precision agriculture, integrated pest management, organic farming, and ecological engineering.

Desired State

- Maximum biodiversity is preserved, and biodiversity is recognized and used as the primary indicator of "ecological health."

- Land is conserved and used efficiently through urban infill, combined with the recycling of land and increasing mass transit-oriented development patterns (e.g., brownfields development, smart growth initiatives, etc.).

- Green spaces are preserved and made off limits to development. Infrastructure corridors are used in environmentally beneficial ways.

- Movements of invasive species are tracked and quickly controlled.

- Environmentally advanced agricultural methods are developed and widely adopted.

- We are able to produce sufficient quantities of healthy foods to feed ourselves and contribute to the world food supply. We are able to do this without degrading the soil, polluting or overusing water supplies, or having other negative impacts that could limit the ability of future generations to meet their own food needs.

Opportunities for EPA

Develop Biodiversity Indicators. Use biodiversity as a primary indicator of ecological health. Work with the academic community and other stakeholders to develop biodiversity indicators for different ecosystems, and utilize these indicators in setting ecological health objectives and in developing ecosystem management strategies.

Develop Natural Resource Damage Assessment as a Management Tool. Employ cost accounting concepts developed for the Natural Resource Damage Assessments (NRDA) and used in establishing Superfund liabilities for other purposes within EPA. Use these concepts preventatively – as management tools in environmental planning and permitting – not just for remediation after damage is done.

Expand Efforts to Control Invasive Species. Significantly expand EPA's efforts and coordination with other agencies to monitor and control the introduction of non-native or invasive species. For example, explore possible joint enforcement opportunities with the states, port authorities and the Coast Guard in restricting point-source discharge of water ballast released by ships. Explore potential roles related to land-based invasives, an area where EPA is now doing virtually nothing. Play a leadership role on this issue in the National Invasive Species Council and the Commission for Environmental Cooperation, which was created by the environmental side accords to the North American Free Trade Agreement (NAFTA).

Develop Natural Resource Partnerships. Continue to develop partnerships and support roles with state Departments of Natural Resources (DNRs), other federal agencies, tribes, local government agencies, commerce and industry, and non-governmental organizations. EPA has not taken full advantage of opportunities to work with these entities, but they are the organizations with the most hands-on

responsibilities for protecting wildlife and biodiversity. Local and national non-profit land conservation and land trust groups have helped protect more than 23 million acres of land and water in the United States. EPA should encourage the transfer of technology and innovations to these and other groups to facilitate better decision-making.

Sponsor Research on Benefits and Costs of Higher Density Development. Sponsor research on the comparative costs and benefits of more compact, mass transit-oriented development patterns and conventional low density development. Look at lifecycle economic costs and environmental impacts. Identify the cost accounting factors that have favored fringe development (e.g. not seeing the full costs up front, tax and other policies that subsidize development on the fringe). Include in this analysis a discussion of non-traditional pollution, i.e., noise and light.

Use SEPs to Encourage Land Conservation. Expand the use of Supplemental Environmental Projects (SEPs) to encourage environmental partnerships for land preservation in urban areas. A SEP is an environmental project that a violator of environmental regulations agrees to perform as part of the settlement of an enforcement action. Although the violator is not legally required to perform a SEP, the monetary penalty imposed on the violator will typically be reduced if the violator agrees to perform an acceptable project. Environmental Restoration and Protection, one of the main categories of acceptable SEPs, allows for purchasing land for conservation programs.

Study Impacts of Sea Level Rise. Initiate and coordinate an interagency examination of the impacts of sea level rise on U.S. shorelines, wetlands, and other affected ecosystems, particularly in the southeastern United States. The examination should also assess impacts on aquaculture and other marine-related economic activities.

Advocate a New Concept of "Environmentally Advanced Agriculture." Assume the role of intergovernmental advocate for a new concept of environmentally advanced agriculture and work with the Department of Agriculture to develop the concept. The agriculture community now tends to think in terms of a polarization between conventional industrial agriculture and organic farming. A new, non-ideological concept is needed that can be a framework for integrating the best ideas from precision agriculture, integrated pest management, and other areas.

Develop a National Strategy to Address the Public Health Impacts of Antibiotics, Hormones and Other Additives in Food Production. Review research on the use of antibiotics, hormones, and other additives in food production to assess the state of knowledge about how they pass into the environment and impacts they may have on public health and other organisms. Identify gaps in understanding and formulate research agendas to address those gaps. Coordinate with other agencies and research institutions to address those gaps and to develop a national strategy focusing on the public health impacts of additives in the nation's food supply.

NATURAL RESOURCES – AIR

Forecast and Context

Air quality improvement is one of the U.S. EPA's greatest achievements. Few people appreciate how polluted our nation's air would be today if not for the success of the Clean Air Act. Yet a new, multi-pollutant approach will be needed to yield further improvements on emerging air quality issues such as: the continuing ozone problems in densely populated areas, the emergence of fine particulate matter as a health threat, the emissions from diffuse sources that are difficult to control and to regulate, air toxins, and the consequences of atmospheric interactions. Shifts to more environmentally advanced technologies, especially in energy generation and transportation, offer great promise.

The possibility of having to expand the use of coal in conventional power generation may pose severe air quality problems. This could happen for electricity generation if renewable technologies are not developed rapidly, or if the expansion of nuclear power is rejected due to concerns for cost, waste disposal, safety and proliferation. It could also happen if political instability in other countries threatens our access to oil.

The EPA Science Advisory Board has noted the possibility of unanticipated environmental problems related to the deposition of airborne contaminants on land and water. Many airborne chemicals are more harmful to human health and ecological systems when acting in the presence of other chemicals. As a result, the deposition and accumulation of multiple chemicals over time may lead to health and environmental problems not anticipated by focusing primarily on air exposures.

Global warming is the greatest long-term, air-related problem because climate change will affect all other ecological systems. The United States is the largest contributor to this problem. With four percent of the world's population, we account for 24 percent of total global emissions of greenhouse gases.[23] In Kyoto, the United States agreed to a seven percent cut below 1990 levels by 2008-2012. However, we now stand at 13 percent above 1990 levels – the highest of all major industrial nations.[24] In addition to chemicals that contribute to climate change, there are a number of conventional and hazardous air pollutants that require international attention and response.

From the perspective of human health, indoor air quality may well pose the greatest environmental risk.[25] A number of studies over the past decade have used portable monitoring equipment to track where people actually experience the largest exposures to different toxic chemicals. In the great majority of cases, these exposures occur inside buildings. While regulations have focused on emissions to the outside environment, exposures are occurring primarily in indoor environments. The exposures come from offgassing from carpets and furniture, sunlight falling on plastics and other materials, construction products, cleaning products, office machines, mildew and molds, and a variety of other sources. Indoor environments do not lend themselves well to traditional command-and-control approaches, so policy innovation will be essential to make major improvements in indoor air quality.

Desired State

- Total exposure to air pollution from all sources does not adversely impact public health, even for susceptible population segments.

- Air quality does not have an adverse impact on the ecological health of forests and other natural systems, or the economic value of land and communities. Air throughout the nation is not contaminated by toxins, criteria pollutants, or particulates.

- A new ideal of "Healthy Buildings" is motivating all companies and government organizations whose work affects building construction and furnishing to eliminate toxins from indoor environments.

Opportunities for EPA

Develop a Multi-Pollutant Approach. Develop an integrated, multi-pollutant approach that includes the sources, the chemistry, and processes of contaminants. Compare the impacts and fate in common for many pollutants, studying and addressing them in a holistic way.

Re-establish an Advanced Automotive Technology Partnership. As the Freedom Car initiative moves ahead to the challenge of using hydrogen as a mobility fuel, we should not neglect the research problems that still remain related to the more near-term deployment of hydrogen vehicles. The Partnership for a New Generation of Vehicles (PNGV) between government and automakers focused largely on developing cleaner, more fuel-efficient electric hybrid vehicles. In the PNGV program, all U.S. automakers were scheduled to begin producing fuel-efficient electric hybrids within the next few years. However, there are still considerable advanced research

problems to solve. The private-public partnership should be re-established to develop cost-effective technologies for large scale deployment of advanced fuel-efficient personal vehicles by the end of the decade. Key areas for near-term cooperation include: advanced internal combustion engines, lightweight body materials, and other aspects of ultra-efficient vehicle design.

Continue to Support Research and Development for Advanced Transit, Including Commercial Trucks. Explore the potential for a partnership with the Department of Transportation (DOT) to study transportation efficiency alternatives, including future point-to-point on-demand transportation, and renewable energy powered light rail and high speed inter-urban systems. The 21st Century Truck Partnership is the private-public partnership which develops and deploys the technologies necessary for safe, clean and efficient commercial trucks and buses. Key areas for advances include: clean and highly efficient engines, fuel cells, hybrid powertrains, lightweight materials, and ultra-efficient aerodynamic designs.

Support Research on Ultra-Clean Coal Technology. Partner with DOE to explore the feasibility of "ultra-clean coal technology" that could allow significantly greater coal use without incurring climatic harm. For example, one concept that has been suggested but not yet explored is to extract hydrogen from coal for use in fuel cells, and to sequester CO2 and other waste gases released in the process.

Use Voluntary Cooperation to Address Indoor Environmental Quality. Increase awareness and expand EPA's role related to indoor air and the indoor environment. The EPA study, *Healthy Buildings, Healthy People,* promotes voluntary initiatives to increase public information about construction materials, furniture, carpets, and cleaning chemicals.

SCIENCE AND TECHNOLOGY

Forecast and Context

Today's rapid pace of scientific discovery and technological change will likely accelerate. We are still near the beginning of multiple revolutions in information and communications, biotechnology and genomics, materials and manufacturing, energy efficiency and production, transportation, construction, and agriculture. Because these developments interact, advances in one area stimulate progress in others. The result is a dramatic technological acceleration.

This acceleration will bring new capabilities for identifying pollutants and better science for assessing risks. The U.S. Environmental Protection Agency (EPA) needs to continually improve the science behind its risk assessments. In this and other endeavors, EPA will be significantly challenged to keep up with positive developments in areas such as: early biological markers of degradation, risk analysis for different genetic subpopulations, sensor technology, and geo-spatial technologies for environmental intelligence. The manufacturing of goods and services will become increasingly *boutique*, while technological acceleration will pose difficult problems. New chemicals and products will be developed faster than they can be tested. There will be unanticipated environmental impacts of technologies thought to be benign, and new environmental issues around genetic engineering, including concerns for biological terrorism. Technology will also evolve faster than accompanying legal, moral, ethical and economic frameworks.

Nanotechnology, the capability to manipulate things at the molecular, and eventually the atomic level, will fundamentally change materials science. In chemistry, designer enzymes will allow biological reactors to manufacture a myriad of substances, from fibers to pharmaceuticals, with production capacities far greater than today's

chemical catalysis. In biology and medicine, genetic construction will allow the repair of defective genes, as well as the creation of new DNA sequences, resulting in entirely new genetic characteristics. In environmental science, highly efficient microorganisms and smart membranes designed to filter out specific compounds and metals will enable ever greater pollutant removal efficiencies. And in electro-engineering, miniaturization will continue nearly unabated to the level at which quantum mechanical effects become dominant.

The good news is that these new technologies and production processes can sharply reduce environmental impacts. Such advances may result in developing nations becoming more affluent without degrading their environments. These technologies will be based on improving resource efficiency, closing the loops of materials flows, and other *Design for the Environment* strategies. We already know how to double the efficiency of electric motors, triple the efficiency of lights, automobiles and most household appliances, and increase the efficiency of buildings by factors ranging from two to ten. In the same way, improvements in durability, recycling, minimum materials design, and elimination of waste can enable far less manufacturing to produce the same desired flow of products and services. This is why the European Union recently adopted the goal of a fourfold ("Factor Four") gain in resource productivity. The Organization for Economic Cooperation and Development (OECD) Environment Ministers, the government of Sweden, and a number of distinguished industrial and academic leaders in Europe and Japan have gone further to advocate a Factor Ten goal for 2050.

Today's best practice engineering incorporates environmental considerations from the outset into the basic design and redesign of products, processes, and technical and management systems. An emerging field of *green chemistry* is developing chemical technologies that minimize or eliminate hazardous substances during the design, manufacture, and use of chemical products and processes. The most advanced industrial designs are increasingly closing the loops of materials flows, reusing materials or turning the waste of one process into feedstock for another. DuPont, for example, recycles nearly a billion dollars of used photographic film per year using a process called reverse logistics.

This kind of approach may ultimately lead us to eliminate the entire concept of waste and treat pollution as a design failure. Emissions will be regarded as *unsaleable production*. The motto of businesses developing the most advanced production systems is, "If we can't sell it, we shouldn't produce it – we should design it out."

These new generations of environmentally advanced technologies are, or soon will be, practical from both an engineering and economic perspective. But, they must overcome many barriers, from lack of knowledge among investors to environmental regulations that thwart innovation. Speeding the emergence of these technologies is a fundamental environmental and business challenge today.

Despite the impressive gains in knowledge and technology, environmental decision-makers almost always face uncertainty in terms of available data, its interpretation, and the likely impact of alternative responses to collection and evaluation. In an effort to address this paralysis by analysis, some governments have embraced a concept referred to as the "precautionary principle." As invoked in the Rio Declaration on Environment and Development, the precautionary principle states, "Where there are threats of serious or irreversible damage, lack of scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation." The challenge lies in defining threats in a way that is protective but not prohibitive. As noted earlier, improving the quality of analytical and scientific tools used in EPA risk assessments will lead to more informed decision-making.

Desired State

- *Design for the Environment* is a universal practice. People working in applied science, technological development and engineering have environmental objectives in mind from the outset of their work.

- Environmentally advanced technologies in all areas of the economy utilize energy and materials efficiently and use closed loop processes that eliminate the concept of waste.

- Good science is the basis for justifying and adjusting environmental standards. EPA is able not only to keep up with developments in science and technology, but also to directly facilitate scientific and technological innovations that help it effectively carry out its mission.

Opportunities for EPA

Create Partnerships for Energy Efficiency. Collaborate with the DOE to leverage investments in energy efficiency from the nation's largest capital pools by creating partnerships with sectors neither organization has traditionally engaged. Among them are: the financial community, property-casualty insurance industry, bonding industry, community development sector, commercial leasing sector, and the group of stakeholders investing in Clean Air Act compliance. Using Cooperative Research and Development Agreements, work with these sectors to quantify and verify the economic benefits of energy efficiency in terms credible to industry leaders. Technology verification would give industry greater confidence in the benefits of energy efficiency, leading to greater investments as verified technologies are mainstreamed into each industry's capital outlays and customer incentive structures.

Develop New Regulatory Relief Strategies to Encourage Technological Innovation. Review EPA program areas to assess emerging technological innovations that involve major improvements in resource efficiency, closed loop processes, green chemistry and other *Design for the Environment* approaches. Develop new programs, faster and less cumbersome than Project XL, that demonstrate the environmental performance of innovative technologies, while rewarding superior environmental performance with regulatory relief and flexibility. Mandate careful monitoring of environmental impacts and regulatory action within a reasonable period of time if problems arise.

Marshal Sound Science to Develop and Defend Standards. Develop greater scientific capacity for developing realistic, protective environmental performance standards and the legal capacity for supporting states, tribes and local officials in defending the environmental standards they are mandated to enforce. Create a one-stop help desk where state, tribal and local officials can locate EPA scientific and legal expertise.

Lead by Example. Work systematically to make EPA facilities and operations a model of technologies and practices that need to come into widespread use. For example, upgrade EPA facilities with more efficient lighting, glazing, and other building systems wherever feasible. Make choices of carpets, furniture, cleaning products, office machines and other products on the basis of energy efficiency and indoor environmental quality. Use hybrid fuel electric vehicles and fuel cell powered vehicles as they become available.

Promote Emerging Developments in Biotechnology and Nanotechnology. Support ongoing environmental scanning to identify emerging developments in biotechnology and nanotechnology. The scan should identify potential dangers that may need to be addressed by policy actions, as well as developments with high potential for facilitating environmental improvement. Examples include: emerging bioremediation methods, biotechnology approaches to hydrogen production, and bio-industrial processes that can replace the use of toxic chemicals and inherently dirty combustion processes. EPA should also explore and facilitate developing environmental monitoring technologies – from real time pollutant sensors to DNA micro arrays – for assessing human and ecological health.

INFORMATION MANAGEMENT AND ACCESS

Forecast and Context

Information – coupled with public education and access – is central for aligning the efficiency of markets with environmental protection. Greater use of market-based strategies and voluntary agreements require informed involvement by all participants. Informed involvement requires access to high quality information. We will find it much easier to reach agreement on solutions if all stakeholders have access to information they trust about key factors such as:

- Changes in the state of the environment
- Location and extent of environmental hazards
- Risks to human health and ecosystems
- Policies, programs, and institutional responsibilities for environmental protection
- Environmental performance of corporations and public institutions
- Knowledge and technical innovations for solving environmental problems
- Product evaluations for making environmentally sound purchasing choices

Better coordination is needed to integrate information from many sources. Where appropriate, information needs to be presented in ways that are easy to understand, with technical terms minimized or clearly explained. Where feasible, organizing information by watershed or by community or zip code-specific formats can make it more useful to citizens. Greater support for environmental education can help the public understand environmental issues and interpret available information. Providing vital information in a variety of other languages, as well as English, can help more citizens gain access.

Technological progress will create dramatic new capabilities for information collection and management in future generations. For example, improved remote sensing using high spatial and spectral resolution satellites, airborne, and in-situ observation systems will allow for near real time monitoring of a wide variety of environmental problems. This information can be fed into automated change-detection decision support systems to provide alerts to both regulators and the regulated community. The rapid convergence of advancing geospatial information systems (GIS), visualization products and Internet capabilities will revolutionize the display of environmental information. Advances toward miniaturized, ultra-sensitive, inexpensive sensor technologies will allow communities, businesses, and even individuals to monitor exposures. In the design of some environmental intelligence systems, a balance will need to be found between the advantages of completely open access and a need to block access to information that could be used to carry out acts of environmental terrorism.

New technical capabilities will empower non-governmental organizations, as well as governments and corporations. Global Forest Watch, an international network of local forest protection groups organized by the World Resources Institute, suggests the possibilities ahead. Local groups linked by the Internet and a common data-gathering format will eventually monitor all of the world's remaining old growth forests, recording on digital maps any illegal cutting, burning, or other violations of forest leases. This information will be posted on the Internet.

Better and more widely available information changes behaviors. For example, the disclosures of toxic releases under the Emergency Planning and Community Right to Know Act quickly led to voluntary reductions – more than 40 percent in the first five years.[26] The ultimate goal of improving information management and access is simple, yet profound. The better information we have about the environment, the better basis we will have for wise decision-making. The more information we have about the environmental behavior of all our institutions, the more incentives there will be for environmental responsibility.

Desired State

- All stakeholders have easy access to accurate, understandable information necessary for making informed environmental decisions.

- Environmental information is effectively used for decision-making and performance management.

- Environmental information is fully integrated and efficiently managed, and is seamlessly exchanged among all stakeholders.

- Environmental indicators are fully developed as the primary gauge of system health, and are effectively integrated with other environmental information.

Opportunities for EPA

Expand EPA's Information Role. Focus EPA efforts far more strongly on environmental education and disseminating information to the general public and other stakeholders. Discuss priorities for improving information management and access with a wide range of stakeholders. Build on current practices with proven effectiveness. For example:

- EPA's recently announced Environmental Indicators Initiative.

- The Technical Assistance Grant process at Superfund sites is an effective model of working with the public to share information.

- ENVIROMAPPER, which offers information on air and water emissions, and facilities in and out of compliance, could be made much more accessible and user friendly to people outside EPA.

- Expand community information access programs, such as *Windows to the Environment*, to invite the public to participate in the collection and analysis of real time information.

Invest in Geospatial Technologies. Incorporate geospatial technologies into EPA's regulatory, rulemaking, and compliance procedures. As part of this effort, develop a cross-Agency policy to embrace performance-based equivalent measurement technologies. EPA has completed a year and one-half long study of GIS, GPS, remote sensing and visualization tools for monitoring, measuring and mapping environmental impacts. Currently, EPA is assessing where these technologies can help business sectors. As this review process is completed, EPA should develop a blueprint for bringing these technologies into full use.

Improve Information Coordination. Expand EPA's ongoing information coordination role, engaging state, tribal and local regulators and other entities involved in environmental monitoring and incorporate their information into unified databases. EPA should also expand its programs that standardize and share environmental data with other nations and multilateral institutions.

Monitor Innovations in Sensing Technology. Monitor fast-moving developments in sensor technology (biosensors, chemical noses, micro electro-mechanical systems (MEMS), nanomaterial-based sensors, etc.) that promise to make inexpensive, miniaturized, ultra-sensitive sensors widely available for detecting environmental contaminants.

Perfect Integrated Monitoring Strategies. Concurrent with innovations in sensing technology, EPA should promote the development and testing of integrated monitoring strategies that allow "total human exposure" assessments to all pollutants across all media, effectively taking into account synergistic effects of multi-pollutant and multi-media exposures.

ECONOMICS AND COMMERCE

Forecast and Context

Ecosystems are the foundation of economic enterprise. Natural and managed ecosystems provide many familiar and marketable goods such as: crops, seafood, livestock, forage, timber, natural fibers, biomass fuels, and many pharmaceutical and industrial inputs. Ecosystems also provide a vast array of ecosystem services that are much less familiar because they are not traded in the marketplace: purifying water, cycling nutrients, regulating atmospheric composition and climate, dispersing seeds and pollinating plants, controlling pests, building topsoil, and assimilating and detoxifying society's wastes.

Even the most conservative calculations suggest that the value of these ecosystem services is greater than today's gross world product.[27] Indeed, these services are invaluable, since without them every economy would permanently collapse. Economic and environmental well-being are ultimately inseparable. The U.S. Environmental Protection Agency (EPA) needs to expand its current efforts to quantify and, whenever possible, monetize the benefits associated with environmental protection and improvement. A full cost accounting of all costs and benefits associated with environmental programs is necessary to support effective and efficient decision-making.

A comprehensive overview of the world's ecosystems prepared by the United Nations, the World Bank, and the World Resources Institute concluded that, "There are considerable signs that the capacity of ecosystems, the biological engines of the planet, to produce many of the goods and services we depend on is rapidly declining."[28] The decline is fastest in some of the world's poorest nations, creating the prospect of future ecological-economic development failures. Affluent nations face special environmental risks related to possibilities for terrorism and economic disruption.

Command-and-control policies that use laws, regulations, and standards to influence behavior are sometimes the only effective way of protecting ecosystem goods

and services. However, command-and-control approaches have real economic costs because they tend to deny firms the flexibility to innovate and respond in the most cost effective manner. As a result, environmental regulations are increasingly being supplemented by cooperative partnerships and by market-based instruments such as: taxes, pollution charges, tradable quotas, or pollution emission permits.

In the United States, the amount of consumer waste, particularly in electronic products, is growing astronomically. It is estimated that 31 million personal computers will become trash next year, and that number may double by 2007. All of these electronic goods contain small amounts of toxic substances (including lead, mercury, and heavy metals) that collectively can become a national environmental problem. The increased implementation of producer take-back programs, similar to those introduced in Europe, could help minimize this pending problem. A few states are making modest steps in the direction of product take-back programs, but much more needs to be done.

A consistent pursuit of ways to align the efficiency of markets with environmental protection will lead toward a future in which the structure of the economy increasingly shifts from selling things to selling the "services that things provide." In today's economy, providers profit by selling more things more often, increasing the "throughput" of energy and materials through the economy, which is the primary source of environmental impacts. A shift toward selling the services that things provide changes the incentive structure for providers and consumers alike, so that both benefit from solutions that are more energy and materials efficient.

Already some U.S. companies are moving in this direction. For example, Carrier, the world's largest manufacturer of air conditioners, is experimenting with selling "comfort services" rather than air conditioners. This shift creates a situation where the best way for Carrier to boost its profits, and give its customers more comfort at lower cost, is to increase the energy efficiency and durability of its equipment. Similarly, Dow is shifting toward providing "pesticide services" and carpet manufacturer Interface is selling "floor covering services" rather than carpets. In fact, Interface actually retains ownership of the floor covering product and recovers worn product from its customers' facilities for

reprocessing into its next generation of product. In each case, both provider and customer profit from minimizing rather than maximizing the flow of energy and materials. Fostering this shift in business strategy and economic structure may be the most effective way to speed the emergence of environmentally advanced technologies.

Desired State

- Effective protection of the capacity of ecosystems to produce valuable goods and services through sustainable global development and restoration of damaged ecosystems. A large middle class emerges in all developing nations, with rapid growth in resource productivity, jobs, wages, capital, savings, profits, knowledge and education, combined with rapid declines in poverty, waste, and pollution.

- Integrative policies treat the goals of economic growth, environmental protection, and social equity as mutually reinforcing, and recognize environmental justice as an essential component of social equity.

- Prevention of ecological-economic development failures in poor nations, with cooperative international actions to respond to emergency situations.

- More effective use of market-based instruments, voluntary agreements, and partnerships to achieve environmental objectives without impeding commercial transactions or incurring unnecessary costs. The economic consequences of environmental actions are well understood.

- A widespread shift from selling things to selling the "services that things provide."

Opportunities for EPA

Support International Policy Coordination. Support the development of an over-arching legal instrument or forum, such as the United Nations Commission on Sustainable Development, to review and verify attainment of global environmental goals in an integrated manner.

Provide Alerts on Substandard International Environmental Practices. Cooperate with international environmental organizations to identify high environmental risk manufacturing practices and to minimize the potential for migration of such practices to developing and economically-stressed regions.

Assist in Preventing Ecological-Economic Development Failures. Cooperate with the Department of State, the United Nations Development Programme, and other appropriate organizations to develop a capability to identify serious environmental problems that could lead to conflicts or ecological-economic failures in developing nations. In partnership with other national and international organizations, develop capabilities for providing economic support, environmental restoration, and assistance in health infrastructure development to help nations avoid or deal with crises.

Support U.S. Industry Contingency Planning. Become a leader in developing the environmental side of contingency planning, encouraging and supporting industry to anticipate environmental problems that might occur with a sharp economic decline, terrorism or natural disasters. EPA sector-based programs can help businesses identify dangers within particular industrial sectors and understand the potential environmental and health risks associated with economic stress. Support industry with national actions, e.g., an underground storage tank trust fund, or bonding arrangements to ensure for costs of environmental remediation.

Support Government and Community-Based Emergency Management Planning. Under the Clean Water Act, broaden emergency management plans to include terrorist activity. Assure that infrastructure management systems have adequate contingency plans for acts of terrorism, including ecoterrorism, as well as other environmental surprises. Provide guidance to other agencies at different levels of government on reviewing their emergency management plans for environmental issues.

Improve the Permitting Process to Foster Environmental Justice. Environmental justice needs to go hand-in-hand with economic development. To prevent disproportionate impacts to poor and minority communities, modify the process of permitting new facilities to adequately take into account cumulative and multimedia impacts of nearby facilities. Identify all sources of emissions, including non-point sources, and account for health conditions in communities when evaluating risk. Today, newly permitted facilities might comply with environmental regulations, but may add significantly to the quantity of pollutants already present and cumulatively create major health risks.

Expand EPA Product Stewardship and Design for the Environment Efforts. With technology acceleration and globalization causing a proliferation of products in U.S. markets, comprehensive testing of their environmental impacts will not be possible. In order to cope, EPA needs to move up the production chain to encourage manufacturer product take-back, other product stewardship arrangements, and a wide range of *Design for the Environment* approaches. Cooperative agreements among consumers, government and industry that give businesses more responsibility for end-of-life management of products create incentives to redesign products with fewer toxins, making them more durable, reusable and recyclable. Voluntary partnerships with industry, universities, research institutions, and other government agencies can help businesses find cost effective ways to bring environmental

considerations into the design of products, processes, and management systems. Large corporations can influence the behavior of thousands of smaller companies by writing quality specifications for their suppliers that keep toxins and materials that cannot be reused or recycled out of their products. More emphasis on voluntary approaches does not imply that EPA should give up a product testing role. However, EPA will need to develop strategies for selecting the most important targets.

Continue to Identify Cost-Effective Environmental Technologies. EPA should continue to identify and bring to market the best practices and most cost effective environmental technologies by expanding its Environmental Technology Verification program (ETV). The ETV program verifies the performance of commercial-ready environmental technologies, and partners with the U.S. Agency for International Development (USAID), U.S.-Asia Environmental Partnership Program (USAEP), and the Department of Commerce.

Co-Sponsor Industry Conferences on "Selling The Services That Things Provide." The EPA's sector-based programs can partner with industry associations, universities, environmental organizations, and other stakeholders to hold conferences for different industry groups on the concept of shifting from selling things to selling the services things provide. The conferences can feature expert presentations and reports by industry innovators who have already adopted this approach, and participatory "how to" working sessions.

POLITICS AND SOCIAL EVOLUTION

Forecast and Context

Without much fanfare, a historic redistribution of decision-making roles is underway in many nations today, including the United States. Power is leaking away from nation states in all directions: upward, downward, and sideways. This pattern of change will have enormous implications for environmental protection, for better or for worse. Moreover, the gap between the "haves" and the "have nots" is widening. According to the World Bank data on poverty, the ratio of global average income of the top five percent to the bottom five percent has increased from six to 186 in the past 20 years.

The shift upward is related, in large part, to the growth of multinational corporations and their evolution from loose collections of national firms into truly global enterprises. Less known, but just as important, is the growing array of international economic and political institutions. More than 5,900 international governmental organizations and networks operate today, and many are quite influential in their own spheres of activity.[29]

The shift downward is moving some decisions to regional, state, tribal and local levels. In the United States, this new federalism has been evolving under both Democratic and Republican administrations. A similar phenomenon is underway in many industrial nations.

The shift sideways involves a wide array of privatization arrangements and public-private partnerships. It also includes the growing role that non-governmental organizations (NGOs) are playing in governance at every level. NGOs bring issues to attention, propose and influence solutions, and monitor the behavior of corporations, governments and other entities. They are increasing their influence by linking into

transnational networks, coordinating their efforts globally, and moving at Internet speed. The EPA will have to be flexible and adjust to the challenge of working with these networks because information technology has enabled them to reconfigure alliances around specific issues.

It is possible to imagine a future where this pattern of change leads to great improvements in environmental protection. NGOs at every level would focus attention on environmental problems and suggest solutions. International institutions and conventions would structure global responses to global problems. Transnational corporations would transfer environmentally advanced technologies around the world, set high environmental and social standards for their own operations, and establish independent monitoring practices. National governments would support global environmental treaties, make greater use of market-based instruments and voluntary partnerships, and ensure that state and local governments have the capacity to maintain standards. State and local governments would react responsively to the conditions they face, innovate, and share lessons of experience. The lowest level of governance able to produce the desired result would always have the primary role. Business, government, and NGOs would have increasingly cooperative, rather than antagonistic, relationships.

Unfortunately, it is also possible to imagine a future where this pattern of change undermines environmental protection. Key nations could fail to support global treaties and conventions. Lack of support for the United Nations and other international institutions would limit their effectiveness. Many global corporations would engage in a "race to the bottom," moving operations to nations where environmental standards are weakest. National governments would fail to maintain environmental standards, fail to accelerate the emergence of environmentally advanced technologies, and fail to ensure that states, tribes and local governments have the capacity to carry out their delegated responsibilities. Decisions and actions will determine which way our society evolves today.

Desired State

- Environmental decision-making takes place at the level most appropriate to achieve desired results.

- The United States consistently approaches environmental protection from a global perspective, not just a national perspective.

- Full compliance is maintained with environmental standards at the national, state and local levels.

- Distributed and informed decision-making, with effective capacity building and performance monitoring, allows state, tribal and local governments to react responsibly to environmental conditions.

Opportunities for EPA

Sustain U.S. Global Participation. Devote far more attention to improve and support global environmental initiatives and conventions. U.S. participation in formulating and achieving global environmental objectives needs to be sustained and consistent. The United States is a major environmental player on the world stage, but not the director. If our nation is to remain a major player, it has to engage.

Support Information Needs for Greater Transparency and Accountability. Globalization of digital technologies is creating a radical expansion of connectivity that allows people to more easily seek and exchange information on a global scale. NGOs are using these capabilities to seek out information about the performance of corporations and governments, to share that information widely, and to coordinate environmental activism more effectively around the world. Over the decades ahead, all major corporations will come under scrutiny. Society is in the early stages of a transition phase, from a comparatively opaque, low information state to a high information state with much greater transparency and accountability. What should it be like on the other side of this transition when good information on the environmental performance of all institutions is widely available? What information on environmental performance needs to be universally collected? What information quality assurance roles

are necessary? How can redundant reporting requirements on companies be minimized? What roles can NGOs play best, and what are their information needs? What forms of involvement will do the most to assure responsible corporate and NGO behavior? Thoughtful responses to these questions could allow EPA to make extremely important contributions to domestic and international environmental protection.

Support The Global Reporting Initiative. EPA has given a small level of financial support to the Global Reporting Initiative (GRI), established by the Coalition for Environmentally Responsible Economies (CERES) in partnership with the United Nations Environment Programme (UNEP). EPA should consider expanding this support and providing it on an ongoing basis. The mission of the GRI is to promote international harmonization in reporting information on corporate environmental, social and economic performance. It is being developed with the active participation of corporations, NGOs, accountancy organizations, business associations, and other international stakeholders. Twenty-one pilot companies, including major U.S. firms such as Baxter International, Bristol-Myers Squibb, Ford, General Motors, Proctor & Gamble, and Sunoco, have tested and improved initial draft reporting guidelines. By 2002, participants hope to establish the GRI as a permanent, independent, international body with a multi-stakeholder governance structure.

Expand EPA's Role in Regional, State and Tribal Capacity Building. Expand EPA's role in capacity building to ensure that EPA regions, and the state and tribal governments they serve, have the skills needed to carry out their delegated responsibilities. Then ensure that states, tribes and regions are given the maximum authority and independence that can be delegated.

Improve Capacity to Track State and Tribal Environmental Performance. Identify gaps and improve EPA's capability to track the performance of state and tribal governments with delegated authority for EPA functions. Support

ongoing efforts of the *Results-Based Initiative* to integrate EPA and state performance information. This will require significant improvements in compliance reporting and better performance measures. While EPA has developed some abilities to measure inputs and outputs, it currently lacks a systematic method for assessing the effectiveness and efficiency of its major program activities.

Reinstate Federal Oversight Capacity for Distressed State Programs. EPA should fulfill its responsibility to help failing state-delegated programs to attain established environmental objectives and carry out major program responsibilities.

Create New Opportunities for NGO and Stakeholder Input. Throughout EPA, establish new mechanisms that reach out to NGOs and other organizations, establish new relationships with a broader range of stakeholders, and provide them with formal opportunities for input. Key areas for soliciting input include stakeholder views on priority problem areas and suggestions for improving EPA's strategies, services and operations.

SECTION IV.
CONCLUSIONS

The National Advisory Council for Environment Policy and Technology (NACEPT) developed this report in an effort to play a more active, strategic role in advising the U.S. Environmental Protection Agency (EPA). Through this process, NACEPT gained insight into the commitment, skills and resources involved in futures planning. While NACEPT at times struggled with questions of process, it made great strides in understanding what works, and what does not work, in creating an environmental foresight radar. It is important to note, however, that these are still first steps and much more can be done.

NACEPT looks forward to continuing this work with the EPA Administrator and in partnering with the program offices that have worked so hard to initiate and lead strategic and futures planning. We hope that with this report, EPA will select specific emerging challenges and opportunities and return to NACEPT for further consultation. We look forward to EPA's response to this report and to future efforts to scan the environmental horizon.

SECTION V.
SUMMARY OF RECOMMENDATIONS

In developing the recommendations contained in this report, the National Advisory Council for Environmental Policy and Technology (NACEPT) recognized that many require coordination with, or action by, agencies beyond EPA. NACEPT has divided the ***Opportunities for EPA*** into the following categories:

A. **Immediate:** Those that appear to be both technically feasible and within the scope of EPA's mission, and could be implemented immediately through commitment of appropriate resources.

B. **Mid-Term:** Those that appear to be technically feasible in the near future, but may lie outside the scope of EPA's mission and/or require coordination with other agencies.

C. **Long-Term:** Those that require substantial research and development and/or coordination with other agencies prior to implementation, but offer long-term rewards.

A. IMMEDIATE OPPORTUNITIES

World Population and Demographics

- Raise domestic awareness of the importance of sustainable development.
- Facilitate export of environmentally superior technologies through revitalization of the Environmental Trade Workgroup of the Trade Promotion Coordination Committee.

Natural Resources - Energy

- Expand the Energy-Star Program broadly across all consumer product sectors.
- Establish a Green Vehicle Labeling Program to identify automobiles that are both energy efficient and manufactured using environmentally friendly components and processes.

Natural Resources - Water

- Integrate water efficiency with water quality standards and other regulations.
- Expedite the pending Pretreatment Streamlining Initiative in the Office of Water to address water quality/water efficiency conflicts in the effluent guidelines programs.

Natural Resources - Biodiversity, Land, and Food

- Enhance the use of Supplemental Environmental Projects in pending and future enforcement actions to encourage land conservation and restoration efforts.

Natural Resources - Air

- Follow up the Office of Air and Radiation's report "Healthy Buildings, Healthy People" with a national voluntary partnership for a toxin-free indoor environment.

Science and Technology

- Move beyond Project XL with new, simplified regulatory relief strategies to spur superior environmental performance and technological innovation.
- Lead by example with a clear, Agency-wide commitment to environmental excellence, beginning with the EPA Strategic Plan.

Information Management and Access

- Expand EPA's information role through increased focus on delivering environmental education to the public.

Economics and Commerce

- Continue to identify cost-effective, emerging environmental technologies through the Environmental Technology Verification program.
- Support disaster preparedness by state and local governments, communities, and U.S. industry through development and delivery of comprehensive vulnerability assessment tools, and resources to implement effective contingency plans.
- Expand EPA's product stewardship and *Design for the Environment* efforts to ensure the development of environmentally responsible products and services.

Politics and Social Evolution

- Enhance EPA's own capacity to track state and tribal environmental performance to accurately assess the effectiveness of its major programs.
- Enhance the capacity of EPA regional offices and states to effectively carry out their delegated program responsibilities, including providing compliance assistance to regulated entities.
- Promptly reinstate federal oversight capacity for distressed state programs where states fail to fulfill delegated program obligations or consistently fail to attain environmental objectives.
- Engage NGOs and other non-traditional stakeholders in identifying effective community-based approaches to environmental protection.

B. MID-TERM OPPORTUNITIES

World Population and Demographics

- Elevate EPA's international role in providing credible information on the environmental, economic and social impacts of population growth and consumption, and in supporting global sustainable development networks.

Natural Resources - Energy

- Encourage development of total cost accounting for energy technologies to facilitate responsible energy development.
- Spur investment in renewable energy resources and energy efficient technologies through Clean Air Act State Implementation Plans.
- Promote market-oriented policies and programs for reducing greenhouse gas emissions.
- Demonstrate methane-to-hydrogen conversion and hydrogen energy technologies at publicly-owned treatment works.

Natural Resources - Water

- Develop a holistic approach to water and the environment, working with EPA, other federal agencies, and non-government stakeholders.
- Redouble efforts to effectively include non-point sources in water management programs.

Natural Resources - Biodiversity, Land, and Food

- Continue to develop partnerships with state agencies responsible for wildlife preservation and biodiversity protection.

Natural Resources - Air

- Develop a multi-pollutant approach to address air emissions from diffuse sources.

Science and Technology

- Marshal sound science in developing and defending environmental standards.

Information Management and Access

- Expand EPA's information coordination role with state and local regulatory partners and other entities performing environmental monitoring.
- Invest in and incorporate geospatial technologies into EPA's rulemaking, regulatory and compliance procedures.

Economics and Commerce

- Implement a global alert system to identify high environmental risk manufacturing processes to minimize migration of these practices to economically vulnerable nations and communities.
- Integrate cumulative risk assessment into EPA and state permitting processes to foster environmental justice.

Politics and Social Evolution

- Support the Global Reporting Initiative pilot projects currently being tested at major multinational corporations.

C. LONG-TERM OPPORTUNITIES

World Population and Demographics

- Establish an "Envirocorps" to complement the international aid efforts of the Peace Corps.

Natural Resources - Energy

- Support innovative research on sequestering carbon in energy production.
- Encourage research and development of hydrogen as a primary energy carrier.
- Partner with the Department of Energy (DOE) on the new *Freedom Car* project that will develop hydrogen fuel celled motor vehicles in the next ten years.

Natural Resources - Water

- Support an effective market environment to minimize generation of hazardous waste through pollution prevention, source reduction, and other initiatives.

Natural Resources - Biodiversity, Land, and Food

- Develop comprehensive biodiversity indicators as primary indicators of ecological health.
- Expand domestic and global efforts to identify and control invasive species.
- Sponsor research on the benefits and costs of higher density community development.
- Assess the ecological and economic impacts of rising sea levels resulting from global warming.

- Advocate environmentally advanced agriculture practices.
- Develop a national strategy to address the public health impacts of antibiotics, hormones, and other food additives in food production.

Natural Resources - Air

- Re-establish an advanced automotive technology partnership.
- Support research and development for advanced transit systems, including commercial vehicles.
- Support research on ultra-clean coal technology.

Science and Technology

- Create investment partnerships for energy efficiency.
- Identify and promote environmentally beneficial developments in biotechnology and nanotechnology.

Information Management and Access

- Monitor and promote the use of new sensing technologies in environmental monitoring.
- Perfect integrated monitoring technologies that allow "total human exposure" assessments to multimedia and multi-pollutant exposures.

Economics and Commerce

- Support the development of an international legal instrument to review and verify environmental performance.
- Assist in preventing ecological and economic development failures.
- Encourage conversion through informational outreach from a "goods" economy to one that provides the services that these goods provide.

Politics and Social Evolution

- Support U.S. participation in global environmental initiatives and conventions.

ATTACHMENT A

Charge to the National Advisory Council for Environmental Policy and Technology

Emerging Trends and Issues Workgroup

Background

In 1999, the National Advisory Council for Environmental Policy and Technology (NACEPT) undertook a tenth anniversary study to evaluate its impact and effectiveness, and to chart a course for its future by identifying ways to better serve the U.S. Environmental Protection Agency (EPA). The study recommended that NACEPT become proactive and operate strategically to identify policy issues for the Council to address. EPA agreed that NACEPT can play a valuable strategic role and encouraged the Council to identify areas where NACEPT believes stakeholder input would aid EPA decisionmakers.

A March 2000 NACEPT planning session, and the Reinvention Action Council (RAC) meeting in June 2000, resulted in discussions about NACEPT's new role as an anticipatory and visionary body. The Council agreed to help EPA with the conceptual design of a process for identifying emerging issues affecting EPA over the next five to ten years.

Committee Charge

The Emerging Trends and Issues Workgroup agreed to use a two-pronged approach to become a more strategic and visionary body. First, NACEPT will identify a

process to enhance EPA's (and/or NACEPT's) ability to identify emerging trends and issues that will affect EPA over the next five to ten years. Second, NACEPT will identify emerging issues and trends, assign priorities, and prepare issue papers for presentation to the NACEPT Council. The initial work of the group will focus on the following activities:

- Produce an interim report of emerging issues and trends.
- Organize proposed emerging topics into overarching themes.
- Dialog with a futurist to help identify and prioritize significant issues and trends.
- Identify models used by corporations with units dedicated to examining future events and trends.
- Invite EPA representatives to give presentations on the historical perspective of EPA's strategic planning process and the budgetary analysis of core issues.
- Recognize that the identification of emerging trends and issues is an evolving process.

ATTACHMENT B

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